UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

ATBG-SEC-AVN-4662

9 JUL 1962

SUBJECT: Report of Test, Project No. AVN 4662, Evaluation of an Autonetics Stabilization System Installed in a Bell Model 47J Helicopter.

7 P.

TO: Commanding General
United States Continental Army Command
ATTN: ATDEV
Fort Monroe, Virginia

1. AUTHORITY. Under the provisions of paragraph 5n, USCONARC Pamphlet No. 705-1, "Materiel Developments Program, FY 1963," June 1962, this Board has conducted an evaluation of an Autonetics Stability Augmentation and Automatic Flight Control System to determine whether this system has sufficient military value to warrant further Army interest.

2. BACKGROUND.

a. A need exists for a simple, lightweight, yaw-axis stabilization device for helicopters to be utilized in the armament role. Current Army development efforts have not, as yet, produced satisfactory equipment to meet this requirement. A simple stabilization device would also enhance the instrument capability of a helicopter.

b. In 1959 the U. S. Navy evaluated an Autonetics Stabilization System in an HTL-7 type helicopter under Bureau of Aeronautics Project No. TED ADV AV-37006. During this evaluation personnel of the US Army Aviation Board had an opportunity to see the equipment and were impressed with its performance and light weight. Subsequently, representatives of Autonetics, a Division of North American Aviation, visited this Board and offered an improved system for evaluation.

c. The Autonetics Stabilization System provided for evaluation is presently undergoing tests for FAA certification for use in the Bell Model 47J Helicopter. A similar system has been evaluated by the US Army Electronic Proving Ground, in an H-19 Helicopter as Task 17-0001, "Stability Augmentation System for Rotary Wing Aircraft."

d. The equipment was received for evaluation installed in a company-owned Bell Model 47J Helicopter on 14 May 1962.

3. DESCRIPTION OF MATERIEL.

a. The Autonetics Stabilization System (SAS-Autocruise) is a prototype, three-axis stabilization system. Axes of control are pitch, roll, and yaw. The system, employing conventional solid state electronics, senses the action of attitude and directional gyros and a rate gyro, and transmits this information to identical electromechanical pitch, roll, and yaw actuators. The electronic package contains three identical plug-in type modules for the pitch, roll, and yaw channels.

b. The system offers two modes of operation, SAS and Autocruise. In either mode of operation the system can be overridden, and manual control of the helicopter assumed.

c. Controls consisted of an on-off switch, an SAS-Autocruise selector switch, and a heading selector for use with the Autocruise function.

4. TESTS.

a. Physical Characteristics.

(1) Size and Weight.

(a) The pitch, roll, and yaw actuators used in the test installation measured 10.5" in length with a maximum diameter of 1.75" and weighed 2.2 pounds each.

(b) A miniature rate gyro, measuring 3" x 1.25", weighing less than 1/2 pound, was used in the yaw channel.

(c) Since the system was a prototype and was coupled to potentiometers and recording equipment, the size and weight of the electronic package were not determined; however, the manufacturer proposed to install the production electronics modules in a package 3.75" x 7.25" x 4.0" at a weight of not more than 3.5 pounds.

(d) The total weight of the proposed system, according to the manufacturer, will be nine pounds.

(2) Installation Requirements. Since the test item was already installed in the helicopter when it was received for evaluation, installation requirements could not be determined; however, manufacturer's representatives stated that a system could be installed in an HU-1B in two days.

(3) Electrical Requirements. The manufacturer reported that the system required 1.35 amperes at 28 volts d.c., and 47.9 v.a., 115-volt, 400-cycle power.

b. Operational Characteristics. The Bell Model 47J was flown approximately 15 hours by personnel of this Board, the US Army Aviation School, and the US Army Aviation Human Research Unit during the period 14-25 May 1962. The system was evaluated using the SAS and Autocruise modes while firing the XM-1 machine gun kit and while performing routine helicopter flight maneuvers.

(1) Four and one-half hours were flown with a single XM-1 gun kit installed. Five aviators who had previous experience in armed helicopters fired 500 rounds each using both the SAS and Autocruise modes; a marked increase in accuracy resulted throughout the firing range. The Autocruise mode was found to be the more suitable for firing and after an initial yaw of less than two degrees, the system maintained the established heading throughout a burst.

(2) Approximately 7.5 hours were flown in the performance of routine helicopter flight maneuvers.

(a) In the SAS mode the helicopter maintained an established attitude until displaced by turbulence or until manually overridden. After being displaced from an established attitude, the helicopter tended to return to the original attitude. This feature was considered highly desirable for nap-of-the-earth operation.

(b) With the system in the Autocruise mode, the helicopter maintained or, if displaced, returned to an established attitude and heading. When operating in the Autocruise mode, manual control of the helicopter could be assumed and the helicopter flown normally. When manual control was terminated, the helicopter returned to the original heading and attitude.

(3) The Autonetics SAS-Autocruise as tested was a limited authority (15 percent) system. The system could be engaged, transient-free, at any time without adversely affecting control of the helicopter, and authority was established from the point of engagement. To establish a new reference (re-center the actuators) the force-trim switch was engaged and held for ten seconds after establishing a desired flight condition to allow time for the actuators to re-center.

(4) In the SAS mode, large center-of-gravity (CG) changes caused a gradual divergence in the direction of the CG movement. In the Autocruise mode, however, the helicopter would diverge slightly and return to its original attitude.

c. Personnel. Helicopter-qualified aviators required only a brief orientation flight to become familiar with the operation of the equipment.

d. Tactical Suitability.

(1) The Autonetics SAS-Autocruise system provided satisfactory stabilization for the helicopter under the most adverse conditions anticipated during the armament mission.

(2) The Autonetics SAS-Autocruise system increased the safety of nap-of-the-earth missions by providing the pilot a stabilized platform from which to observe and navigate.

(3) The Autonetics system cannot be considered a complete autopilot and has only 15 percent authority (manufacturer's statement); however, based on the limited evaluation, it is considered capable of duplicating the performance of other stabilization systems in the SAS mode and of holding an established attitude and heading indefinitely in the Autocruise mode.

e. Maintenance. Maintenance was performed by the manufacturer's representative and consisted of changing a solid-state inverter.

f. Pilot Opinion. Rotary-wing instructor pilots of the Army Aviation School evaluated the equipment. Their comments are summarized as follows:

(1) With the SAS-Autocruise system engaged, the handling qualities of the helicopter were improved in all regimes of flight.

(2) It was considered that this equipment would reduce pilot fatigue, simplify initial instruction, and enhance the instrument capability of the helicopter.

(3) The light weight, simplicity, and alleged low cost of the equipment were impressive.

(4) Any unfavorable comment dealt with features peculiar to the prototype installation rather than performance of the system.

(5) One pertinent comment was, "This system meets all the manufacturer's claims."

(6) Further evaluation was recommended.

5. DISCUSSION.

a. The system evaluated was experimental and did not represent a production configuration. The instruments installed in the test helicopter were driven by commercially available, vacuum-driven gyroscopes that are not considered suitable for Army use

in helicopters. It was noted during this evaluation that the system precisely followed the precession errors of the instruments, which indicated that the system will be only as precise as the instrument system installed in the helicopter. Autonetics has ordered lightweight, electrically-driven instruments that have been designed specifically for use in helicopters and will replace the vacuum-driven system as soon as they are available.

b. Based on the manufacturer's data, the system was found to be lighter in weight and lower in cost than single-axis systems previously evaluated (references d and e) and currently under test by this Board (reference f).

6. CONCLUSIONS.

a. The design philosophy of the Autonetics Stabilization System (SAS-Autocruise) which features interchangeability of actuators, and electronic modules would greatly simplify supply and maintenance.

b. The Autonetics Stabilization System (SAS-Autocruise) warrants further Army interest.

7. RECOMMENDATION. It is recommended that expeditious action be taken to acquire:

a. The Autonetics Stabilization System (SAS-Autocruise) for evaluation in an HU-1( ) Helicopter equipped with an SS-11 ATGM System.

b. The Autonetics Stabilization System (SAS-Autocruise) for evaluation in reconnaissance and utility helicopters.

8. REFERENCES.

a. Aeronautical Instruments Laboratory, Report No. NADC-AL-5977, 5 October 1959, "Evaluation and Flight Test of Light Weight Helicopter Rate Stabilization Device," Bureau of Aeronautics Project No. TED ADC AV-37006.

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b. Plan of Test, USAEPG-SIG 950-48, "Stability Augmentation System for Rotary Wing Aircraft (SAS)," Task 17-0001, US Army Electronic Proving Ground, November 1960.

c. Message, ATBG-ACAR 5-69, US Army Aviation Board, 31 May 1962.

d. Report of Project No. AVN 2260, "Helicopter Mounted SS-11 Anti-Tank Guided Missile System (U)," US Army Aviation Board, 6 June 1960.

e. Letter, ATBG-DT AVN 457.2, US Army Aviation Board, 28 May 1958, subject: "Evaluation of the Lear Super Arcon."

f. Plan of Test, Project No. AVN 3961, "Evaluation of the Yaw-Axis Portion of the Automatic Flight Control System AN/ASW-12 (V) Installed in an HU-1( ) Helicopter for Use With the SS-11 System," US Army Aviation Board, 1 June 1961.

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